renouncing technical or professional education, the University renounces all those who must have such education at the age when she might receive them. Those who really value, as we do above most things, breadth of intellectual interests—who have intense repugnance to narrow "specialism"—cannot, upon due consideration, defend the separation of "ornamental" and "technical" education, as likely to conduce to increase of culture among our fellow-countrymen. It is by undertaking most fully the charge of the higher education—of those for whom without distinction such education is necessary—that the Universities can really do most for the cause of culture. When Oxford and Cambridge succeed in getting hold of all such students then only can thoroughly satisfactory results be expected by those who are anxious for the progress of the higher education. What we desire more earnestly is, that Oxford and Cambridge may be the means of giving breadth of view and interest to as large a number of young Englishmen as possible, for it is this that we understand by "culture:" not the mere ease of manner due to luxury and the select association of leisured men. Oxford and Cambridge can spread true culture, and can have pretensions to such an office only when acting up to their trust and fully providing for the very best and fullest professional study in all departments. There are some to whom it appears important that the Association should plainly declare itself on this matter, before proceeding to the question of the foundation of institutions for scientific and literary research within the University. If on the one hand the Association were to declare for the exclusion of professional study, and at the same time to advocate the foundation of increased means and material of research within the University, we should feel at once that the policy of the Association would not be accepted by all. There is a great deal of human nature in the men who occupy distinguished positions in our Universities, and in the select atmosphere of non-professional students and cultured ecclesiastics there is an inevitable languor and repose of the mind which are infectious. The most vigorous body becomes limp before the sirocco, and in this atmosphere of luxurious culture it may be doubted whether even Faraday could have carried out his investigations: probably only by investing himself in a kind of mental diver's costume. On the other hand, the presence of an active body of those who for want of a better word we may call professional students—of men who, having neither time nor money for self-indulgence, determinedly work round their professor—the presence of a whole lot of such professors each so surrounded, and the association thus established between the Universities and the progress of the body of the country in the arts and sciences, would bring about a gigantic change. Professors so surrounded might with advantage be largely increased; the purely ornamental students would be by no means dislodged—they would remain in numbers then as now—but beneficially influenced by the example of the career-seeking and professional student. These in their turn would be benefited by a duly proportioned infusion of those students seeking exclusively "culture"—the amateurs and patrons of serious pursuits.

It is, then, only on the basis of professional training in the widest sense of the term, that we should care to see a reorganisation of Oxford and Cambridge. Let the colleges be taxed, say, to the extent of fifty per cent. of their revenue in order to support the professoriate and the appliances which each faculty may deem adequate, not only for direct "student teaching," but for progressive research. Then we may hope to see our Universities elevated from the condition of mere finishing schools for young gentlemen. If such a plan cannot be carried out, it would seem useless to simply create sinecures within the old places, larger and probably less productive than those which at present exist. Sharp and painful though the measure might be—we should in that case have to yield to the removal of means which have so long lain idle. The colleges would be relieved of their excessive income to support more practical institutions elsewhere, and Oxford and Cambridge would collapse into the condition of mere theological seminaries. When the Association meets on Saturday next, it would be well that this point should be raised, lest by the silence of the leaders of the movement, any one should be lukewarm in its support.

FRICK'S PHYSIKALISCHE TECHNIK

Oder Anleitung zur Anstellung von physikalischen Versuchen und zur Herstellung von physikalischen Apparaten mit möglichst einfachen Mitteln. Von Dr. J. Frick. (Braunschweig, 1872.)

THIS most useful book has now reached the fourth edition, and has swelled to 700 pages, illustrated by 986 wood engravings. To some British physicists and teachers the work has already proved itself serviceable, but there are doubtless many to whom it is at present unknown who would find much valuable information therein.

Dr. Frick's work is not in any sense a manual of experimental physics; it is rather an elaborate treatise upon physical apparatus and the methods of physical research. Its object, we learn from the preface, is to give an introduction to the methods of conducting physical inquiry, to enumerate the precautions which it is necessary to adopt in order to ensure success, and to give ample directions with reference to the construction of apparatus and its management. This field is, comparatively speaking, untrodden before, and we have no hesitation in saying how thoroughly successful Dr. Frick's attempt to guide us over it has proved. We shall briefly indicate the contents of the book, and then point out the few matters in which we think the execution of the task has fallen short of what might have been fairly expected.

The first part contains a sketch of the arrangements necessary for the physical laboratory, and a detailed account of the methods of manipulating glass, metals, and other materials which are required for the apparatus described in the second part. This portion of the book is very interesting and useful. We find here numerous hints on turning, glass-blowing, and similar processes with which it is well for the physicist to be acquainted. In the second part we have in Chap. I. a description of the apparatus necessary for the study of the equilibrium of forces applied to solids, liquids, and gases; Chap. II. describes the apparatus used for experiments on motion

© 1873 Nature Publishing Group

Chap. III. is on acoustics; Chap. IV. on light; Chap. V. on magnetism; Chap. VI. on electricity; Chap. VII. on heat. It may be remarked that the figures are drawn to scale, and further illustrations of the details are added whenever necessary.

As a fair specimen of the illustrations and descriptions we may refer to Article 121, wherein is described Müller's apparatus for studying experimentally the free falling of a body. This beautiful contrivance is for the purpose of causing a point vibrating horizontally to trace a curve up on a board descending vertically. From the form of the curve the law of falling bodies is deduced. In Chap. IV. we meet with many interesting contrivances: for example, Fig. 433 represents an arrangement for showing the principle of the rainbow experimentally by the aid of spheres of glass. This chapter is concluded by a practical lesson in photography. Many of the figures in Chap. VI. will be found to represent electric instruments which are manifestly great improvements on forms in ordinary use. As an example we refer to the Rheostat, Fig. 775.

Considering the book has already reached such portly dimensions we can hardly complain of omissions. We are, however, of opinion that the space at the disposal of the author might have been more judiciously employed if some of the apparatus which he has described were omitted and some instruments which he has passed over were inserted instead. To illustrate this remark we may refer to the chapters on mechanics. We there find a number of ingenious contrivances generally pretty well known, but we also meet with toys like those described in articles 66 and 67 which could, we think, have been very well dispensed with. On the other hand we seek in vain in the same chapter for a full account of Willis's system of mechanical apparatus. To say that this ingenious system would, with trifling additions, enable all the mechanical experiments described by Dr. Frick to be performed is to give a very inadequate idea of its resources. In the hands of a competent experimenter Willis's apparatus will be found to provide in a substantial form the principal parts necessary for nearly every conceivable experiment in mechanical philosophy. The framework of this apparatus is so useful in almost any physical research that we cannot conceive how it could have been omitted from "Physikalische Technik," had the author of that work been acquainted with the writings of Prof. Willis. We think also that some of the host of merely qualitative experiments described for the purpose of illustrating centrifugal tendency (Article 124) might very well be omitted. On the other hand, we miss Smeaton's machine, which, admitting as it does of exact quantitative results being determined, is perhaps, next to Atwood's machine, the most useful instrument we have for illustrating the truths of dynamics.

We are tempted to think that Dr. Frick is not adequately acquainted with English scientific literature. This opinion receives some confirmation when, on turning over 238 closely-printed pages which describe electrical apparatus, we fail to see Sir William Thomson's beautiful instruments described; nor on turning to the Index do we even find the name of that philosopher mentioned.

Although we decidedly think this book might have been better, yet we decidedly think that it is very good, and we cordially recommend it to the notice of physicists and lecturers, who will certainly find it useful.

OUR BOOK SHELF

Electricity. By R. M. Ferguson, Ph.D., F.R.S.E. (W. and R. Chambers.)

We regret that the Elementary Treatise on Electricity has not been revised by its author since its first appearance. For example, useful as is the chapter on the absolute measurement of an electric current, its usefulness to students would be increased by a fuller and more detailed explanation. At the foot of p. 159 it is stated that "the heating effect (of the current) depends on the strength of the current and the resistance." It should be the *square* of the strength of the current into the resistance, as is correctly stated in a preceding paragraph. On p. 153 there is a mistake in the calculation of the quantity of water decomposed by a current; 60 c.c. × tan. 51⅓ = 75 c.c., and not 80 c.c., as is stated, and afterwards assumed. A description of the sine-galvanometer ought hardly to have been omitted, and a fuller explanation, together with an engraving of Thomson's reflecting galvanometer, ought surely to be given. There is also but a meagre account of the induction coil, and the function of the condenser is not explained: the term *rheotom* instead of contact-breaker, looks pedantic, and may puzzle some readers. But the most faulty part of the book in our estimation is the singularly obscure and misleading manner in which the terms Electric Quantity and Tension are defined on p. 64. Tension is spoken of as synonymous with electric depth, or as the French say, electric thickness; whereas the tension, pressure, or power of discharge possessed by any electrified point, varies as the *square* of the electric depth at that point.

The first part of this text-book relates to magnetism and more evident care has been bestowed on this portion. The charts of isogonic and isoclinic lines are most useful, and so also are the chronological appendices, in which a brief scientific history of each subject is given. But why could not the dip and declination be given for a later year than 1865? It is said on page 16 that two magnetic needles are absolutely necessary to show "the power of the earth in determining the position of the needle," and that "if it were possible to hang a needle in the air so as to leave it perfectly free to take any position, it would show us fully the directive action of the earth." Is it not possible to buoy a magnetic needle in water, or sink it in mercury, so that the action of gravity may be neutralised, and the directive influence of the earth wholly come into play? Moreover, many dipping needles are made with a swivel pivot, by means of which the declination and dip are roughly shown at the same time. Two other blunders we notice in the part on magnetism. On page 4, speaking of a "small magnetic bar or needle," Dr. Ferguson says that "if both poles of the needle are attracted indifferently by any end of it [a bit of iron], it is not magnetic." This is as slipshod in its science as it is in its English, for it is precisely the test of a magnetic body that it does attract either end of the needle; magnetic should of course read magnetised, and so again a few lines lower down. The other blunder is on page 14, where it is said that "cobalt is attracted by the magnet at the highest temperatures." It is well known, and can easily be shown as a class experiment, that cobalt loses its magnetic character at a white heat. But in spite of these errors, Dr. Ferguson's "Electricity" is a book that has been of much use to both teachers and students of science. Its obvious merits lead us to hope that a revised edition may find it free from the defects to which we have drawn attention.

© 1873 Nature Publishing Group